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Report of the PSARC Habitat Subcommittee Meeting December 7-8, 1999

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Pacific Scientific Advice Review Committee (PSARC)
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE

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HABITAT SUBCOMMITTEE

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SUMMARY

The PSARC Habitat Subcommittee met December 7-8, 1999, at the Institute of Ocean Sciences (IOS) in Sidney, B.C. The Subcommittee formally reviewed four Working Papers (Appendix 1). One report was presented, but could not be formally reviewed because the report had not been circulated to Subcommittee members prior to meeting start (Appendix 1). Dr. Ian Perry, Chair, Invertebrate Subcommittee, attended December 7th, to provide the Subcommittee with an overview of the Invertebrate Subcommittee's Working Paper entitled, "A review of the biology and fisheries of the goose barnacle (*Pollicipes polymerus* Sowerby, 1833)", along with a review of Working Paper H99-4. Dr. Robie Macdonald, Department of Fisheries and Oceans, provided information on his experience in the Arctic (Appendix 4) with Traditional Ecological Knowledge (TEK).

INTRODUCTION

The Subcommittee Chair, John Pringle, opened the meeting by welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed, and the Subcommittee accepted the meeting agenda (Appendix 2).

A number of external participants and observers attended: Thomas Tomascik (Parks Canada) attended as an external participant for the entire meeting and contributed to various discussions. The following attended as observers for H99-4: Jamie Muirhead, Trevor Hamilton, and Nina and Ian Rudiak. Reviewers Don Hall, Cliff Robinson and Christine Soto (tele-conference) presented excellent reviews of Working Papers. A list of meeting participants is available as Appendix 3.

Participants were reminded the meeting deliberations are confidential until the publication of the meeting's Advisory Document.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

H99-2: Hexactinellid sponge reefs on the British Columbia continental shelf: Geological and biological structure with a perspective on their role in the shelf ecosystem

K.W. Conway **Accepted subject to revisions**

Summary

Globally unique sponge reefs, dominated by species of hexactinellid sponges, occur in deep shelf troughs on the western Canadian continental shelf. Submersible dives reveal these reefs to consist of dense populations of

hexactinosan sponges that include bio-constructions up to 18 m high and many kilometres wide. The non-living portion of the reef 's subsurface is composed of sponge skeletons encased in a matrix of "modern" clay. Three species of hexactinosan sponges form the skeletal framework through the "biological fixing" and deposition of opaline silica, thereby fusing the spicules of individual sponges. This structure allows the inter- and con-specific attachment of juvenile sponges onto dead skeletons; hence the multi-generational aspect of the reefs.

The reefs cover, in patchwork fashion, ~700 square kilometres of seafloor in Queen Charlotte Sound and Hecate Strait at depths from 165 m to 230 m. The mounds (bio-herms) and sheet-like bio-stromes cover low angle, non-depositional iceberg scours, relict since de-glaciation ~13 thousand years ago. The base of the oldest sponge reefs studied date from ~9000 years before present.

The fleshy, delicate sponges could not withstand commercial fish trawling activities. Repeat side-scan sonar surveys carried out over a sponge reef complex in southern Queen Charlotte Sound in both 1988 and 1999, indicates adverse impacts since 1988. Trawl marks, identical to those that would be caused by passage of trawl doors and nets, were observed across many bio-herms in water depths of 210 m to 220 m.

The importance of the sponge reefs to the ecology of the continental shelf is unknown. Qualitative submersible observations suggest species of crab, shrimp, prawns and rockfish utilize interstices within and among the sponges as refugia. It should be noted that core and photographic data point up a cyclicity in sponge abundance over time, with the sponge-poor periods showing greater amounts of sedimentation on the sponge mounds.

The sponge reefs, as geological features, are closely related to Upper Jurassic siliceous sponge reefs, which stretched in a belt 7,000 km wide across the northern Tethys and Atlantic Ocean margins. The analogue, which the modern sponge reefs provide for this extinct reef belt, provide a unique opportunity to gain insight into what is the largest bio-construction yet discovered. In view of the globally unique and fragile nature of the sponge reefs, and the lack of knowledge on their contribution to the shelf ecosystem, recommendations for habitat management include:

1. A moratorium to mobile fishing gear deployment and other types of destructive anthropogenic activity in the known sponge reef complexes;
2. Further biological, biophysical and ecological studies of the sponge reefs to define ecological relationships and the critical physical environmental conditions important for reef formation, growth and reproduction; and
3. Further studies, involving submersibles and other technologies, that would allow assessment of reef "health", and the nature and extent of impacts sustained to date.

Reviewers' Comments

Reviewer 1

The techniques used and conclusions reached appear valid: That the presence of bio-herms has been confirmed; that they are indeed unique features; and that they provide a rare opportunity to provide interpretation for large tracts of fossilized reefs occurring in the Upper Jurassic. The following revisions are suggested:

1. Reorganize the Working Paper to more clearly present the geophysical survey, visualization and sampling techniques; and
2. Enhance discussion by clarifying mechanisms that caused seawater lowering, the winnowing of fine materials from exposed banks, and their subsequent deposition in the shelf troughs.

Reviewer 2

This review was received after the presentation of the Working Paper and thus, was not discussed by the Subcommittee. The reviewer notes that the data are important, but the Working Paper requires restructuring and should not be accepted until the following changes are made:

Introduction:

- Explain reef location and why they are unique;
- Provide an overview of both national and international research on the topic; and
- Include physical information such as glacial and sea level history, seafloor morphology, surficial sediment distribution, and wave and current regimes.

Results:

- Focus on findings, but resist interpretation here.

In addition to the above, the Working Paper requires "tightening up" and certain "statements clarified."

Subcommittee Discussion

The Subcommittee found the topic most interesting and felt the author had prepared a sound paper. Some discussion occurred on the distribution of the sponge reefs; were they located only in iceberg scour tracks only or did oceanographic currents play a role in some of the scours in which the reefs developed? In addition, the author was encouraged to clearly show/explain that:

- Iceberg scouring was necessary for sponge reef formation;
- These are the same species that occur in near-shore fjords; and
- Though iceberg scours occur elsewhere on the shelf, to date the sponge reefs have only been found in Hecate Straits and Queen Charlotte Sound.

The Subcommittee was convinced groundfish trawling would adversely impact these sponge reefs, though evidence is only indirect as the technology used to depict trawl tracts and sponge reef cannot distinguish between dead and live sponges. Given that these reefs appear to be unique to the Pacific Region continental shelf, and that growth rates are low (~1 cm/y), the Subcommittee felt it important that all known Regional reefs be protected from adverse impacts until their ecology and contribution to the local ecosystems are better understood. For example, because of swift currents, the reefs are responsible for the only accumulation of sediments in the area. In addition, the biological communities within the reefs differ from that on the contiguous seafloor, however, analysis are not yet complete. We do know soft corals and sea whips were not found within the reef areas but were found beyond; king crabs, however, were much more abundant within the reef than on the seafloor beyond.

Little information was presented on the distribution of commercially important groundfish in relation to the reefs (to be supplied by Science Branch groundfish personnel). Of interest was the observation that a certain small percentage of the sponges were covered with sediment and were hypothesized to be dead. The Subcommittee then queried the impact on the reefs of sediment stemming from commercial trawling operations. It was noted that sponge reef formations could be recognized on modern day sounders used by fishers, thus trawling impacts could be avoided. In addition, it was explained that fish trawl scours would be too shallow for sponge habitat.

The Subcommittee urged the author to provide clear and concise recommendations. This could in part be accomplished by removing material that would be better placed in the Discussion section of the Working Paper.

Subcommittee Recommendations

1. The Working Paper be accepted subject to revision.

2. Given that the four Hexactinellid sponge reef complexes found in Hecate Strait and Queen Charlotte Sound have yet to be found anywhere else in the world; that individual reefs are estimated to be >8,500 years old; and that they represent the only known analogous subjects to the fossilized sponge reefs that covered large areas in Southern Europe and parts of North America during the Upper Jurassic, it is recommended that:
   - The four reef complexes be protected immediately from potentially damaging fishing methodologies and other mechanical insults. Long-term protection should be provided through Marine Protected Area designation including appropriate regulations to prevent reef degradation;
   - Studies should be conducted to determine the areal extent of the reefs and their ecology with emphasis on an attempt to understand their overall role in the Queen Charlotte Sound and Hecate Strait ecosystems; and
   - Given that these reefs were discovered by accident, searches should be

conducted for other unique shelf habitats and species complexes. This could begin with:

- A request of fishing vessel observers to document all biological species captured in fishing operations; and
- An analysis of fishing vessel observer logs.

H99-3: Options for ballast water treatment and disposal to reduce risk of non-indigenous species (NIS) introductions to Pacific Region waters

C. Levings and T. Sutherland **Accepted subject to revisions**

Summary

To minimize the risk of introducing non-indigenous species (NIS) to distant coastal waters via ballast water discharge, vessels are encouraged to exchange ballast mid-ocean when and where safety permits. The operation ensures that most of the harbour ballast water in a ship's tanks (estimates of mid-ocean exchange efficiency vary widely, but are usually considerably <100 %) is replaced with mid-oceanic water, that theoretically contains organisms unable to survive coastal conditions.

Vancouver Port Authority (VPA) developed a mandatory ballast water exchange program to reduce the risk of NIS introductions to waters under their jurisdiction. Protocol, established in 1997 under the VPA Harbourmaster's Standing Orders, is incorporated in the draft Canadian national guidelines for ballast water management, and has been adopted by port authorities in New Westminster and Nanaimo. Those ships not having performed mid-ocean exchange (MOE), with certain exemptions, are to be sent westward to Sheringham Point (recently changed from Race Rocks) in Juan de Fuca Strait to discharge ballast. To date, no ships have been sent to the Point.

VPA exemptions for ships carrying ballast water from coastal waters north of Cape Mendocino, California, or for those weighing <1,000 tonnes should be assessed. The first exemption enhances the risk of moving NIS from ports in Oregon and the outer Washington coast to Pacific Region waters. Ships in the second category carry sufficient water to harbour NIS and hence, have the potential to contaminate the Region's waters.

Personnel from the above-mentioned port authorities interview ship masters to determine if MOE has occurred during the voyage to BC ports. In addition, they spot check the ships ballast waters for salinities <25 psu (practical salinity unit) or that bear a preponderance of bottom dwelling coastal copepods (harpactacoids) over oceanic copepods (calanoids). If the interview with the Master along with the review of the accompanying log book suggest mid-ocean exchange to have occurred and the spot check shows oceanic conditions, the Master is then given

permission to proceed with ballast water discharge in the harbour. If there is evidence MOE has not occurred, nor no justification for it not having been done, the vessel could be sent to the alternate ballast disposal location near the mouth of Juan de Fuca Strait. Procedures should be developed to:

- review the compliance information, and to
- discern if the biological test is scientifically defensible.

In addition, other BC ports (e.g. Prince Rupert, Victoria, etc.) should be encouraged to take measures to reduce the risk of NIS introductions to their respective waters.

Given the inherent problems in executing MOE, methods are required to kill NIS in ballast water. To this end, Pacific Region science personnel in April, 1999, carried out preliminary experiments dockside, on VPA property, to nullify the hypothesis that the Velox Ballast Water Treatment System (VBWTS) would reduce survivorship of natural populations of certain planktonic species. Seawater samples were collected from sites along the two treatment stages of the System and analyzed for survivorship. The diatom, *Chaetoceros gracile*, appeared the most sensitive to the UV-C treatment, exhibiting a 4-day lag phase prior to growth. In general, cell concentrations and growth rates of the UV-treated cultures were significantly lower relative to controls. To investigate the null hypothesis that the delayed growth of UV-treated *C. gracile* occurred due to a photo-repair mechanism, and also to more accurately reflect ballast water transport conditions, a dark-storage experiment was carried out on the original samples preceding a second incubation; the UV-treated cells did not resume growth.

Further studies are underway to determine critical flow rate and UV exposure required to produce 100% mortality rates. In addition, impact of the system on invertebrate larvae [*Mytilus trossulus* (mussel), *Cancer magister* (Dungeness crab), *Venerupis philipinarium* (Manila clam), *Crassostera gigas* (Japanese oyster), and *Artemia* (brine shrimp)] is being studied. Approximately, six UV-C intensities will be used per species. Data evaluated to date reveal that 100 % mortality can be achieved through a combination of cyclonic and UV-C irradiation treatments.

Ballast water may contain viruses, bacteria, algae, phytoplankton, zooplankton, fish and associated cysts and eggs. In order to determine the efficiency of single- or combined-treatment systems it is essential a matrix experimental design be employed that incorporates a wide variety of organism types. Survivorship/mortality rates for each plankton type requires vastly different techniques, some of which consist of long-term incubation techniques (cysts, eggs, and microbes). Biological testing and technology design should be an iterative process to fine-tune treatment technologies to efficiently remove or kill target species.

Reviewers' Comments

Reviewer 1

This reviewer, a leading university researcher in the NIS field, felt the Working Paper provides a thorough review of ballast water exchange and hydro-cyclone treatment methodologies, however, he recommended inclusion of other technologies, with particular emphasis on filtration technology research under way in the Great Lakes.

He agreed with the authors' recommendations, but suggested the following be considered:

- Enhance the first recommendation by including more thorough studies of coastal shipping ballast waters for an assessment of those organisms most likely to survive short coastal voyages;
- Countries begin studies on vessel design to facilitate ballast water management; and
- Canadian officials continue, and possibly expand their involvement in international fora involving attempts to develop local and larger-scale solutions to NIS introductions.

Reviewer 2

The reviewer, a habitat manager, was most encouraged to have this Working Paper as a contribution to the growing problem of NIS introductions. She recommended the following:

- That further scientific support be provided for the authors' concerns for the VPA Standing Order protocols underlying the use of mid-oceanic ballast exchange. It should be stated that ports such as Oakland, California are adopting the VPA standing order protocols, hence all the more reason for the protocols to be assessed scientifically;
- That the Working Paper include the following recent references, "Pacific Ballast Water Group Draft Report" (1999), "The Global Response to the Ballast Water Issue: Implications for Australian Bulk Exports" (1998), and "Ballast Water and Shipping Patterns in Puget Sound";
- That the authors reword the purpose of the VPA protocol. She claims it is not to conserve marine ecosystems, but merely to "...limit the possibility of transferring non-indigenous species into Canadian waters."
- That the Working Paper include reference to Section 5 of Model Ballast Water Management Plan (1998), which would enhance the rather "thin" section on mid-ocean exchange methodologies;
- That the Working Paper have a transition into the Recommendations Section and that the various sections be renamed to better reflect their respective contents;

- Section G should be enhanced to include more of the important "questions being asked by Pacific Regional scientists and managers regarding the role of ballast in minimizing risk of non-indigenous species."; and
- That researchers and habitat managers along the Pacific coast of North America organize a workshop on NIS and ballast water in an attempt to "...sort out research priorities and promote connections between (sic) scientists, agencies, shipping community, etc."

Subcommittee Discussion

It was agreed, some NIS (e.g. zooplankton) could move north from Cape Mendocino via the California Current, but those NIS with poor dispersal mechanisms will only be transported north in ballast water or other vectors. Thus, all west coast ports from Cape Mendocino north should be considered "hot spots" for the presence of NIS - a recommendation supported by Reviewer 1. It was agreed that coastal "leap-frogging" via the various ports can quickly extend ranges of NIS, thus the "Cape Mendocino north" exemption of the VPA protocol should be reviewed.

Because NIS introductions are a serious concern, Fisheries and Oceans Canada should work with the VPA to develop a reporting procedure; for example, an annual meeting should be scheduled where ballast water data files that include compliance records and biological information from spot checks could be reviewed and discussed.

Recommendations to the VPA should identify specific concerns and possible solutions. For example, Science Branch personnel could advise on the development of a scientifically rigorous sampling protocol to test the statistical reliability of the spot check, which is used to confirm the accuracy of the Master's log book in relation to MOE. It was noted that salinity levels in ballast waters are used in other port jurisdictions, but the calanoid: harpactacoid ratios are not; this technique be vetted scientifically. As well, there is need for an extension of the 1996 Fisheries and Oceans Canada sponsored survey for ballast water tank organisms to help identify ballast water-sourced NIS entering VHA waters.

Regarding the Velox technology, where UV radiation is being assessed for its effectiveness in reducing NIS in ballast water, the Subcommittee asked if primary treatments such as ozone, filtration, or heat have been attempted? It was learned that ozone corrodes ship's pipes, and newer vessels do not have the capacity to produce the water temperatures required to sterilize ballast water. Great lakes shipping is experimenting with water filtration, but there are concerns with the clogging of filters when turbid waters are encountered. Given the small size of many planktonic species and their respective reproductive structures e.g. cysts, the cost of filtration for marine waters would likely be prohibitive. Cyclonic sediment separation could reduce filter clogging frequency, but it does induce flocculation, thereby removing biological material prior to treatment.

The Subcommittee felt a need to increase UV dosage testing on a broader range of organism types than has been tested to date, and for an assessment of the degree of sterilization required to significantly reduce the potential for NIS introductions.

Subcommittee Recommendations

1. The Subcommittee accepted the Working Paper content subject to revisions, but recommended that the two distinct sections; the review of the VPA ballast standing orders, and the VBWTS be published as separate Research Documents.

2. The Subcommittee further recommended that:
   - The rationale for the exemptions of ships carrying ballast water from north of Cape Mendocino, California and for vessels <1,000 mt be critically examined;
   - The sampling design and protocol used by VPA to discern the incidence of mid-ocean ballast exchange and its effectiveness in preventing NIS introductions (risk assessment) be reviewed;
   - A protocol for ballast water management be implemented coast wide;
   - A completion of the matrix testing of the VBWTS on a variety of organisms be carried out with an experimental design that includes the following variables; UV dosage (intensity X time), sediment loads, and time; and
   - A matrix design rather than a single-factor design be used in studies carried out in other Fisheries and Oceans Canada Regions where ballast water treatment technologies are evaluated.

H99-4: Phase 1 framework for undertaking an ecological assessment of the outer coast rocky intertidal zone

G. Jamieson, R. Lauzier and G. Gillespie **Accepted subject to revisions**

Summary

The goose barnacle (*Pollicipes polymerus* Sowerby, 1833) fishery was closed by Fisheries Management May 30, 1999 because of recommendations arising from the Phase 0 review of the fishery (Lauzier 1999); issues raised in the Phase 1 paper on sea mussels (*Mytilus californianus*) (Gillespie1999); and concerns expressed by both the Pacific Scientific Advice Review Committee (PSARC) Invertebrate Subcommittee and the Resource Management Executive Committee (RMEC). Any re-opening or further development of the goose barnacle fishery and continuation of bio-toxin monitoring using harvested wild sea mussels would depend on both the results of an ecological impact assessment and the meeting of criteria for new and developing fisheries. A

Phase 1 stock assessment and management framework is being submitted (Lauzier, in prep.) for consideration by the PSARC Invertebrate Subcommittee. The present Working Paper includes a Phase 1 framework for an ecological impact assessment. Both Working Papers will be used to provide an overall assessment framework for the potential re-opening and development of the goose barnacle fishery.

The current Working Paper provides a brief history of both the goose barnacle and sea mussel fisheries, plus a literature review of the biology and ecology of both species. Included as well, is a scientific review of disturbances and recoveries in the rocky intertidal zone. Its important to note that considerable information is available from local studies of the goose barnacle, and in particular on impacts of harvesting. These reviews are followed by an approach for an ecosystem assessment of the rocky intertidal, preparatory to renewable resource exploitation in this ecosystem. Criteria on which to develop a research design are proposed.

Reviewers' Comments

Reviewer 1

The reviewer recommended revision of the Working Paper as follows:

- That recommendations be included to allow habitat and fisheries managers to understand that Phase 1 requirements would include an experimental fishery to assist in the gathering of ecological knowledge;
- That the objectives of the Working Paper be more clearly stated;
- That the biological study take into consideration the information available from past goose barnacle/sea mussel fisheries, and that perturbation studies be scaled to commercial size; and
- That a research and management framework be included rather than a list of studies, and that an adaptive management philosophy be recommended rather than years of research that precludes a precautionary goose barnacle fishery.

Reviewer 2

The reviewer commended the authors on a thorough job and recommended that the following comments be considered in any revision of the Working Paper:

- That a summary of recommendations be included;
- That RMEC's request for an ecological impact assessment be discussed in relation to the authors' recommendation for a series of long-term ecological studies and industry's request for a concurrent experimental goose barnacle fishery;
- That the temporal and spatial scaling problems expressed by the authors might, in part, be resolved by exploring the traditional ecological knowledge (TEK) of harvesters. This knowledge could lead to the development of a list

of harvested beds and their respective harvesting history, which could then be compared to virgin beds; and

- That any perturbation experiments include evaluation of "low impact" and "code of conduct" fishing practices.

Subcommittee Discussion

The Subcommittee requested that the Working Paper recommendations be supplied in a format useful to habitat/ocean managers. One habitat manager noted that the information demonstrates that gooseneck barnacles and mussels are important structural components of their ecosystem, thus fisheries management decisions must be more broadly based than consideration for sustainability of the target species only. Missing from the Working Paper is knowledge on harvesting technology – does it cause collateral damage? Are there vehicles or other heavy equipment used?

Harvesters present as Observers, at the request of the Subcommittee Chair, noted that the goose barnacle fishery is prosecuted on exposed rocky sites by wet-suit clothed harvesters using hand -held prys made from automobile leaf springs. Harvesting occurs on the low tide with the harvesters "...carefully selecting clumps 5-6 inches across with ~20 barnacles to a clump... We always leave some stock behind to reproduce." The crop is bagged on site. Historical records of removal from specific sites are not available from either official or private logs.

The Subcommittee agreed with the Working Paper authors, that timing prevented the marriage of the findings of the stock assessment Working Paper with that of habitat Working Paper and that in the future, the two Subcommittees should work more closely together, with joint meetings where deemed necessary. Data were not available that would allow the Subcommittee to discern the impact of small removals from certain geographic areas; the seeming lack of site-specific harvest information prevents retrospective analyses. In addition, there appears little understanding of that portion of the population available for harvesting in relation to the spatial scale of the colonies. Similarly, because of claims of poor harvest records and under-reporting, inferential analysis may not be available to relate official reports of annual landing declines to harvesting technology or poor fishery management, both of which might impact adversely on long-term productive capacity.

Though little is known about the scale of goose barnacle harvesting impacts and distribution of the fishery, there is considerable knowledge in the literature about goose barnacle biology, ecology and natural history including recovery times from small scale experimental removals. Recovery following commercial harvesting, however, is not known, nor is the impact on productive capacity. The fishers present claimed recovery is largely a function of two physical steady state variables; wave force and swell size. "Some rocks can be re-harvested in six months whereas other areas require three years."

The Subcommittee noted that the Oceans Act suggests ecosystem management allow sustainability over time; that a certain amount of disturbance will be permitted, but only that which will not adversely impact either long-term bio-diversity or productive capacity of the ecosystem. The Subcommittee noted a lack of criteria or reference points, as are available for certain chemical contaminants, on which both habitat and fisheries managers can act. It was agreed bio-diversity, as one such criteria, would be difficult to both study and implement as there is a paucity of both taxonomic data and marine taxonomists.

The Working Paper recommended a long-term ecological study, and after considerable discussion, it was agreed the Subcommittee would recommend an experimental fishery as a key part of the study. The senior author did state that though the Working Paper was not explicit on the topic of a concurrent experimental fishery, he did realize a commercial scale fishery would have to be included in the study, and agreed to have the Working Paper reflect this concept.

The Subcommittee offered that the recent literature does provide considerable information useful for the development of study design. Key information missing is practical ecological targets/criteria that could be used by habitat managers. It was recommended that Science Branch personnel work with habitat/ocean managers to develop ecological objectives for the experimental phase of the study. A small Working Group with members from both the Invertebrate and Habitat Subcommittees along with habitat/ocean/fishery managers and fishers, where required, be struck to develop guidelines and a set of recommendations for the study. The Working Group will identify experimental study areas, including reference sites and sites where adaptive management could be carried out. Seasonality was seen as an important variable and should be included in the experimental design. Parks Canada personnel offered to collaborate on the bio-diversity phase of the study, which could include an assessment of the functional role of keystone species.

Fisheries and Oceans Canada's recent move from single species management to an ecosystem approach was lauded. The Subcommittee, however, noted that basic ecologicial knowledge is far from complete to allow a seamless shift, and that there are few management tools available. To assist this process, the Subcommittee recommended a framework be developed, including the concept of ecological reference points, to address anthropogenic, rocky intertidal ecosystem perturbations.

Subcommittee Recommendations

1. Acceptance of the Working Paper following revisions as outlined above.

2. Longer-term perturbation experiments, that include commercial goose barnacle/ sea mussel harvesting, be designed and initiated that will allow an

evaluation of harvesting impacts on the ecosystem. The habitat, bio-diversity and spatial distributions of key macro-species in the study areas should be described along with other ecosystem characteristics.

3. The establishment of a working group composed of Fisheries and Oceans Canada Science, Habitat, Oceans and Fisheries Management personnel, including stakeholders when and where deemed necessary to:

   - Develop an assessment and management framework for an experimental goose barnacle fishery using recommendations from both the current Working Paper and the invertebrate stock assessment Working Paper (Lauzier 1999);
   - Develop the objectives for an Ecological Impact Assessment of selected rocky shore species;
   - Identify study areas and reference sites that will have little likely hood of being vandalized and that have the ecological characteristics of commercially important areas; and
   - To develop ecological objectives and management criteria for the experimental phase of the proposed study.

4. That PSARC's Habitat and Invertebrates Subcommittees work closely together when considering habitat issues linked to a commercial fishery. And,

5. That a Working Paper be developed for use by habitat, ocean and fisheries managers, which outlines a framework to address ecosystem perturbations in the rocky intertidal along with ecological reference points.

Emerging Issue

The objectives of Ecological Impact Assessments in general, require definition by PSARC. Specifically, recommendations are required on the quantitative criteria that could be used in decision making.

H99-5: An evaluation on criteria for creating MPAs in the Pacific Region: A proposed semi-quantitative scheme

C. Levings and C. Jamieson **Accepted subject to revisions.**

Summary

In this paper, the authors review semi-quantitative methods and criteria developed for evaluating potential Marine Protected Area sites (MPAs), and discuss their use in the Pacific Region. A number of authorities involved in marine conservation have proposed specific criteria or design principles for MPA selection, often following those set out by the International Union for the Conservation of Nature a number of years ago. Most criteria are qualitative,

which renders the selection procedure subjective and difficult to track in an open and defensible manner. However, because of the complexity of marine ecosystems and the lack of site specific data, development of a quantitative scheme is not yet possible, though use of a semi-quantitative scoring system (e.g. high, medium, low) for siting criteria may be practical even when data are incomplete. As a template for both discussion and for the rationale for developing such a scheme in the Pacific region, we used a slightly modified version of the three natural science objectives (bio-diversity, sustainability, and opportunities for scientific research) along with criteria described in the1998 draft Canada/BC MPA discussion paper. We did this with the full realization that socio-economic and other factors important to Fisheries and Oceans Canada partners must be considered in the final MPA selection process. Listed below are factors to consider when evaluating scoring criteria for each of the above-mentioned objectives:

1. Bio-diversity: representativeness, degree of naturalness, areas of high bio-diversity and/or biological productivity, rare and endangered species, unique natural areas, ecological viability, vulnerability, and unique habitats;
2. Sustainability: areas supporting significant spawning concentrations or densities, areas important for the viability of populations and genetic stocks, areas supporting critical species, life stages, and environmental support systems; and for
3. Opportunities for scientific research: value as a natural benchmark; values for developing a better understanding of the function and interaction of species, communities and ecosystems; and values for determining the impact and results of marine management activities.

The authors recommend a working group, with wide representation from the scientific and various public communities, be established to develop a system for weighting and scoring these criteria.

To the extent possible, siting decisions for individual MPAs should be considered in the context of a MPA network. Developing the scientific basis for the configuration of such a network is an important next step.

Reviewers' Comments

Reviewer 1

The reviewer had six major recommendations for this paper.

1. The paper lacks important background information on the MPA strategies in Canada and B.C., and the department's role in the strategies. More detailed background information is critical in order to put the biological selection criteria into context of a larger more comprehensive MPA strategy. As a minimum, specific information should be provided from the MPA strategy document and linked to the three MPA objectives addressed in this paper. The authors should also state clearly that Fisheries and Oceans Canada is

one player in the Canada/BC Marine Protected Area strategy, and discussions with biologists representing the other partners should be included in any discussion of biological selection criteria. This is an important point, because although the department has a lead role, it should not exclude other partners in this process. In addition, the authors should state that science (i.e. biological criteria) is only one component in what some consider a process with considerable political overtones.

2. In the review documents, the authors should look at other agency documents, e.g. Parks Canada.
3. There should be a more consistent structure for each section.
4. The rating system does not go far enough.
5. The terminology and jargon used through out the document should be interpreted and defined by Science Branch.
6. There should be a discussion regarding the merits and problems on the use of cut-offs (e.g. 10% criterion).

The reviewer provided the authors several constructive editorial comments.

Reviewer 2

Reviewer 2 discussed four major issues for this Working Paper:

1. The paper provides a solid starting point for assessing individual "areas of interest" (AOI) for MPA siting via their first recommendation.
2. The authors should review Marine Ecosystem Classification (MEC) schemes and how these might be utilized (converted) into criteria for selecting AOI. This would be helpful, and is similar to Protected Areas Strategy approach (e.g. National Marine Conservation Area - their method has merits and problems and would be worth reviewing in this Working Paper).
3. Consider for the future how Fisheries and Oceans Canada's development of a MEC scheme is critical for developing a MPA network. New criteria would flow from such a scheme. Currently, other agencies utilize "representivity" as a surrogate method of maintaining ecosystem integrity.
4. Under the Oceans Act, Fisheries and Oceans Canada is tasked with conserving and protecting ecological integrity of marine ecosystems. An MPA network is a critical tool for achieving this within the context of Integrated Management plans. A scientific/ecological "backbone" is necessary to provide recommendations on suitable AOI or to evaluate proposals received. Thus, the authors' comment (in Recommendation 1) that consideration of a network is not an immediate priority and should be re-considered. (Developing an approach to ecological integrity will have multiple benefits and efficiencies within Fisheries and Oceans Canada's work in fisheries management, enforcement, integrated management, MPAs, habitat, etc. To better understand marine ecosystem function, Geographic Information Systems can be used to overlay data or patterns of oceanography, substrate type, temperature, salinity, other biological and physical oceanographic variables as well as species distributions. Analyses that identify patterns will

eventually lead to models. For example, the Department can immediately begin to address this through research on the relationship between CHS charts (depths, substrate types etc,) and the Multibeam Sonar images created in several of the pilot MPAs, known species-habitat associations (there are not many known except in a general sense), geographical locations of species as taken by video and further ground-truthing, etc. In the reviewer's opinion ground-truthing is more complex than described in the Working Paper [For a model, see Ward, T.J., M.A. Vanderklift, A.O. Nicholis, and R.A. Kenchington. 1999. *Selecting marine reserves using habitats and species assemblages as surrogates for biological diversity.* Ecological Applications 9:691-698. (Please note, this work is also cited in the Working Paper)]. Results will be relevant to Marine Ecosystem Classification schemes as well as our other areas of work listed above. The science-based ecological backbone should then be used to co-operatively develop, with stakeholders listed in Recommendation 1, a flexible network of areas of interest, which would be further assessed with social, economic and cultural criteria within Integrated Management plans.

Subcommittee Discussion

There was considerable Subcommittee discussion on the integration of scientific criteria with criteria from other disciplines e.g. socio-economic. There is need to develop common indicators, but the weighting or ranking may be different among interests. The Subcommittee agreed with the authors' first recommendation, that there should be a mechanism to meet and refine the semi-quantitative scheme to score and weigh criteria. The criteria thresholds should be strongly backed by scientific information.

There was discussion on Marine Conservation Areas (MCAs) vs. Marine Protected Areas (MPAs). The MCAs will be zoned to allow the addressing of scale and networking issues. The establishments of MPA networks within Integrated Management zones will be tackled in the development of the respective Integrated Management zone plan. There was also Subcommittee discussion on attempting to understand why there are differences between the Fisheries and Oceans Canada MPA selection criteria and the MPA selection criteria under the Canada/BC MPA strategy. It was pointed out that the objectives between the two strategies are somewhat different.

There was also some discussion on the use of the BC Government's Land Use Coordinating Office (LUCO) system used by Parks Canada. It was pointed out that this system was not designed for the rating of criteria for protected areas, though LUCO personnel suggest otherwise.

Subcommittee Recommendations

1. The Subcommittee recommended the Working Paper be accepted subject to

revisions.

2. The Subcommittee concurs with the first recommendation of the Working Paper that a government/non-government organization/fisher/community based Working Group be assigned the task of refining and evaluating the scientific and semi-quantitative scheme described in the Working Paper. The process of scoring and weighting criteria should be open and transparent.

3. The Subcommittee concurs with the secondary recommendations of the Working Paper that:

   - Decisions about individual MPA sites must be viewed in the context of a network of such sites, even where the network is in its infancy.
   - Establishing scientific criteria for MPA networks needs further consideration.
   - The Pacific Region needs a working definition of marine ecosystems acceptable to both scientists and ocean/habitat managers, and which allows such questions as uniqueness and representativeness to be addressed.

4. The Subcommittee recommended testing the semi-quantitative criteria developed in this Working Paper on both Gabriola Pass and Race Rocks AOI (pilot MPAs).

Report: Guidelines to protect fish and fish habitat from treated wood used in aquatic environments in the Pacific Region

K.E. Hutton and S.C. Samis

A penultimate draft of this report (to be published as a DFO Technical Report) was circulated to members of the Subcommittee during the December 1999 meeting. The timing of the circulation prevented an official review of the science in support of the conclusions of the Report, however, it was agreed MEHSD scientists would provide such a review, though separate from the Subcommittee.

Appendix 1: PSARC Habitat Working Papers for December 1999.

No.	Title	Authors
H99-2	Hexactinellid sponge reefs on the British Columbia Continental shelf, geological and biological structure with a perspective on the role in the shelf ecosystem	K.W. Conway
H99-3	Options for ballast water treatment and disposal to reduce risk of non-indigenous species (NIS) to Pacific Region	C. Levings T. Sutherland
H99-4	Phase 1 framework for undertaking an ecological assessment of the outer coast rocky intertidal zone	G. Jamieson R. Lauzier G. Gillespie
H99-5	An evaluation on criteria for creating MPAs in the Pacific Region: A proposed semi-quantitative scheme	C. Levings G. Jamieson
Report 1	Guidelines to protect fish and fish habitat from treated wood used in aquatic environments in the Pacific region	K.E. Hutton S.C. Samis

List of Reviewers

Parrott, R.	Natural Resources Canada, BIO, Halifax, NS
Lim, P.	DFO, HEB, Pacific Region
Systma, M.	Portland State University, Portland OR
Hall, D.	Nuu Chah Nulth Tribal Council
Perry, I.	DFO, Science Branch, PBS
Robinson, C.	Parks Canada, Vancouver, BC
Hale, P.	DFO, Oceans Branch, NCR
Soto, C.	DFO, Oceans Branch, Pacific Region

Appendix 2: PSARC Habitat Subcommittee Meeting Agenda, December 7-8, 1999

PSARC HABITAT SUBCOMMITTEE

DECEMBER 7 - 8, 1999

CENTRAL BOARDROOM, IOS

Starting time, 0930 hours, December 7.

1. Review Agenda
2. Review Minutes of June meeting
3. Review H 99-4: "Phase 1 framework for undertaking an ecological assessment of the outer coast rocky intertidal zone" by G. Jamieson, R. Lauzier and G. Gillespie.
4. Review H 99-2: "Hexactinellid sponge reefs on the British Columbia Continental Shelf, geological and biological structure with a perspective on the role in the shelf ecosystem" by K. Conway.
5. Review 99 - 3: "Options for ballast water treatment and disposal to reduce risk of non-indigenous species (NIS) to Pacific Region" by C. Levings and T. Sutherland.
6. Review 99 - 5: "An evaluation of criteria for creating MPAs in the Pacific Region: A proposed semi-quantitative scheme" by C. Levings and G. Jamieson.
7. Review of the workshop report on "Guidelines to protect fish and fish habitat in freshwater environments in the Pacific Region" by Karen Hutton and Steve Samis.
8. Discussion on Traditional Ecological Knowledge, led by Robie Macdonald.
9. Date and tentative agenda for spring 2000 meeting.

Appendix 3: Participants at Habitat Subcommittee Meeting, Fall 1999.

Fisheries and Oceans Canada Participants

Name	Affiliation
* Subcommittee Members	
L. Chew	DFO, MEHSD[1]
D. Clark	DFO, Fisheries Management
M. Foreman*	DFO, Ocean Sciences & Productivity Division
J. Hume*	DFO, MEHSD, Cultus Lake Laboratory
G. Jamieson*	DFO, MEHSD
T. Johnston*	B.C. Ministry of Fisheries
R. Lauzier*	DFO, Stock Assessment Division
C. Levings*	DFO, MEHSD
R. Macdonald	DFO, MEHSD
I. Perry	DFO, Stock Assessment Division
J. Pringle* (Subcommittee Chair)	DFO, MEHSD
T. Sutherland	DFO, MEHSD
S. Samis*	DFO, Habitat and Enhancement Branch
G. Steer*	DFO, Habitat and Enhancement Branch
C. Soto (Tele-conf. Call)	DFO, Oceans Branch

[1] MEHSD - Marine Environment & Habitat Sciences Division

External Participants

Name	Affiliation
C. Robinson	Parks Canada
D. Hall	Nuu-chah-nulth Tribal Council
T. Tomascik	Parks Canada
K. Conway	National Resources Canada, IOS

Observers

Name	Affiliation
T. Hamilton	Barnacle Co-operative
N. Rudiak	West Coast Goose Barnacle Association
I. Rudiak	West Coast Goose Barnacle Association
J. Muirhead	Barnacle Co-operative

Appendix 4. Traditional Ecological Knowledge and lessons learned in the Pacific and Arctic. Robie Macdonald.

Robie Macdonald, Eddie Carmack and Fiona McLaughlin (all Pacific Region Science Branch personnel) have worked in the Arctic and Pacific alongside First Nations peoples. They have found that dialogue with natives has assisted them in focussing their oceanographic science on relevant issues and identifying ecological phenomena that likely have physical or chemical causes. Robie suggested that TEK does not lead to quantitative data - rather it provides qualitative information. For example, the timing of spring breakup in the Arctic is so important for transport and gathering food that there is considerable TEK available around this phenomenon. The study of First Nations geographic place names often provides the first entry into perspectives of oceanographic and/or ecological processes in that traditional names tend to identify the importance of a site in a practical way (gathering of food/materials rather than a name - for example, Wayne Gretzky Place, if applied by a native, would inevitably suggest a good location to play hockey rather than memorializing an icon). The processes identified in traditional names are sometimes obvious (fish point) and sometimes lead to more subtle insights that might indicate currents or tides (place of clay). Finally, conversations with First Nations at this level often lead to greater respect for traditional knowledge and a meaningful inclusion of it in the planning process.